VERIFICATION OF TRANSLATION

I, undersigned below, hereby declare that:

My name and post office address are as stated below:

That I am knowledgeable in the English language and in the language in which the below identified U.S. Provisional Application was filed, and that I believe the attached English translation of the U.S. Provisional Application No. 60/402,825 filed on August 9, 2002 is a true and complete translation of the above-identified Provisional Application as filed.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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[Name of Document] SPECIFICATION

[Title of the Invention] ENGINE OUTPUT CONTROL DEVICE FOR WATER JET PROPULSION BOAT

[Claims]

[Claim 1] In a water jet propulsion boat that injects pressurized and accelerated water from an injection nozzle located at the rear by a jet propeller when the engine is driven, and moves forward with its rebound,

an engine output control device for water jet propulsion boats comprising:

an engine revolution detection sensor for detecting the number of revolutions of said engine;

a throttle opening detection sensor for detecting the opening of the throttle of said engine;

a steering state detection sensor for detecting whether or not the steering handle is being steered; and

a control unit for controlling the engine revolution based on the signals from said engine revolution detection sensor, the throttle opening detection sensor and the steering state detection sensor;

characterized in that the control unit is adapted to start engine revolution reduction control when a state in which the throttle opening is smaller than the prescribed value is detected based on the signals from said throttle opening detection sensor and a state of being steered is detected based

on the signals from said steering state detection sensor, and change the speed of engine revolution reduction control when the filtered engine revolution under the state in which the engine revolution is under control is reduced to the value smaller than a prescribed engine revolution, and in that said filtered engine revolution is a value obtained by multiplying a coefficient of resistance of the vessel to the change of engine revolution during a prescribed period of time.

[Claim 2] An engine output control device for water jet propulsion boats according to Claim 1, characterized in that said control unit is adapted to start engine revolution reduction control when a propelled state with the filtered engine revolution and the throttle opening being larger than the prescribed values is detected based on the signals from said engine revolution detection sensor and said throttle opening detection sensor, and subsequently, a state in which the throttle opening is smaller than the prescribed value and a state of being steered are both detected.

[Claim 3] An engine output control device for water jet propulsion boats according to Claim 1 or 2, characterized in that said control unit is adapted to perform such engine revolution control that engine revolution reduction control is started when a state in which the throttle opening is smaller than the prescribed value is detected, and subsequently, the speed of engine revolution reduction is changed to the value

different from said reduction speed when a state of being steered is detected based on the signals from said steering state detection sensor.

[Claim 4] An engine output control device for water jet propulsion boats according to any one of Claims 1 to 3, characterized in that said speed of reduction control is determined based on the average engine revolution obtained by detecting the engine revolution for several seconds immediately before the throttle opening which is smaller than the prescribed value is detected for several times and averaging up the detected engine revolutions.

[Claim 5] An engine output control device for water jet propulsion boats according to any one of Claims 1 to 4, characterized in that the engine revolution control by the use of said speed of reduction control is performed by delaying the speed of closing of the throttle valve.

[Claim 6] An engine output control device for water jet propulsion boats according to Claim 5, characterized in that when closing the throttle valve, the speed of closing of the throttle valve is delayed by controlling the speed of the backward movement of a push pin in a state in which the push pin of the stepping motor that moves forward and backward is abutted against the pressed portion of said throttle valve.

[Claim 7] An engine output control device for water jet propulsion boats according to Claim 3, characterized in that

the engine revolution control is released and returned to the initial state when the value obtained by dividing the filtered engine revolution by the initial revolution becomes smaller than the prescribed ratio of cancellation due to reduction of the engine revolution at said reduction speed.

[Claim 8] An engine output control device for water jet propulsion boats according to Claim 6, characterized in that said push pin is adapted to be projected to the position in the vicinity of the pressed portion of said throttle valve when the filtered engine revolution is larger than the prescribed engine revolution, and this state of being larger is continued for a prescribed period of time.

[Claim 9] In a water jet propulsion boat that injects pressurized and accelerated water from an injection nozzle located at the rear by a jet propeller when the engine is driven, and moves forward with its rebound,

an engine output control device for water jet propulsion boats comprising:

an engine revolution detection sensor for detecting the number of revolutions of said engine;

a throttle opening detection sensor for detecting the opening of the throttle of said engine;

a steering state detection sensor for detecting whether or not the steering handle is being steered; and

a control unit for controlling the engine revolution

based on the signals from said engine revolution detection sensor, the throttle opening detection sensor, and the steering state detection sensor;

characterized in that the control unit performs such engine revolution control that the engine revolution is increased once and then is decreased when a state in which the throttle opening is smaller than the prescribed value is detected based on the signals from said throttle opening detection sensor and a state of being steered is detected based on the signals from said steering state detection sensor, and changes the speed of engine revolution reduction control when the filtered engine revolution under the state in which the engine revolution under control is lowered is a value smaller than the prescribed engine revolution, and in that said filtered engine revolution is a value obtained by multiplying a coefficient of resistance of the vessel to the change of engine revolution during a prescribed period of time.

[Claim 10] An engine output control device for water jet propulsion boats according to Claim 9, characterized in that said control unit performs such engine revolution control that the engine revolution is increased once and then is decreased when a propelled state in which the filtered engine revolution and the throttle opening are larger than the prescribed values is detected based on the signals from said engine revolution detection sensor and from said throttle opening detection

sensor, and subsequently, a state in which the throttle opening is smaller than the prescribed value is detected based on the signals from said throttle opening detection sensor, and simultaneously, a state of being steered is detected based on the signals from said steered state detection sensor.

[Claim 11] An engine output control device for water jet propulsion boats according to Claims 9 or 10, characterized in that the engine revolution is increased by connecting an auxiliary air passage to the air intake passage on the downstream side of said throttle valve, and after a state in which the throttle opening is smaller than the prescribed value is detected, introducing air to the downstream side of said throttle valve via the auxiliary air passage.

[Claim 12] An engine output control device for water jet propulsion boats according to Claim 11, characterized in that said air intake passages are provided for each plurality of cylinders, and said auxiliary air passages are connected to each air intake passage, and in that the plurality of auxiliary air passage are converged, and air flow rate adjusting means for adjusting the air flow rate is provided at said converged point.

[Claim 13] An engine output control device for water jet propulsion boats according to any one of Claims 1 to 12, characterized in that said predetermined engine revolution is determined based on the filtered engine revolution obtained

after a state in which the throttle opening is smaller than the prescribed value is detected.

[Claim 14] An engine output control device for water jet propulsion boats according to any one of Claims 1 to 13, characterized in that said state in which the engine revolution is under control is released when the steering handle is returned to the neutral state in a state in which said engine revolution control is being made.

[Claim 15] An engine output control device for water jet propulsion boats according to any one of Claims 1 to 14, characterized in that said state in which the engine revolution is under control is released when the operator opens the throttle in a state in which said engine revolution control is being performed.

[Claim 16] An engine output control device for water jet propulsion boats according to any one of Claims 1 to 15, characterized in that restoration of the initial state is achieved when the engine revolutions is reduced to the value smaller than the prescribed value after a state in which said throttle opening is smaller than the prescribed value is detected and before a state of being steered is detected.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a water jet propulsion

boat injecting a jet flow toward the rear and cruising on the water with its rebound, and more specifically, to an engine output control device being capable of maintaining its steering force even when the throttle is turned OFF.

[0002]

[Description of the Related Art]

The water jet propulsion boat of this type moves ahead by injecting water rearward from the injection nozzle of the jet propeller having an impeller to be driven by an engine, and is adapted to be turned by operating the steering handle and swinging a deflector in the lateral direction by the operator straddled on the saddle-type seat.

[0003]

In order to make it travel in reverse, the deflector for reverse travel disposed rearwardly of the aforementioned injection nozzle so as to be capable of vertical movement is lowered to change the direction of the jet water injected from the injection nozzle toward the rear into the forward direction, so that it reverses with its rebound.

[0004]

Further, it is adapted to change the vessel speed by adjusting the opening of the throttle valve of the engine by gripping-releasing operation of the throttle lever on the steering handle.

[0005]

[Problems to be Solved by the Invention]

However, in the related art as described above, when the throttle is turned OFF, the throttle valve closes almost completely and thus the amount of water injected from the injection nozzle is reduced in either cases of forward travel and reverse travel. Consequently, a thrust that can be used for turning the vessel (thrust that can be used for steering) is reduced simultaneously, and thus the capability to steer the vessel is reduced until the throttle valve is opened again.

[0006]

There are various proposals as countermeasures against this problem, such as those disclosed in the United States Patent No.6159059, the United States Patent No.6336833B1, the United States Patent No.6390862B1, and so on.

[0007]

However, according to the invention of the United States Patent No.6159059, since the period of time until the throttle valve recovers into the idling state when the throttle lever is resumed is elongated, lowering of engine revolution is deteriorated, and thus the stopping distance is also elongated.

[0008]

While in the invention of the United State No.6336833B1, since it is adapted in such a manner that the jet propulsion watercraft is maintained to be easy to control irrespective of a setting of the manual throttle control unit even when the

manual steering control unit is turned in either direction beyond a prescribed threshold value, it is controlled irrespective of the speed. Therefore, the operator can hardly have a natural feeling of steering.

[0009]

Further, in the invention of the United State No.6390862B1, since it is adapted in such a manner that the engine revolution is reduced in the reducing speed which is selected out of predetermined reducing speeds when the operator reduces the speed in manual operation, adequate control according to the vessel speed cannot be made. Therefore, the operator can hardly have a natural feeling of steering.

[0010]

Accordingly, it is an object of the present invention to provide an engine output control device for water jet propulsion boats that allows the operator to steer in more natural feeling even when the throttle is turned OFF.

[0011]

[Means for Solving the Problems]

In order to achieve the object described above, the invention according to Claim 1 is, in a water jet propulsion boat that injects pressurized and accelerated water from an injection nozzle located at the rear by a jet propeller when the engine is driven, and moves forward with its rebound, an engine output control device for water jet propulsion boats

including: an engine revolution detection sensor for detecting the revolutions of the aforementioned engine; a throttle opening detection sensor for detecting the opening of the throttle of the aforementioned engine; a steering state detection sensor for detecting whether or not the steering handle is being steered; and a control unit for controlling the engine revolution based on the signals from the aforementioned engine revolution detection sensor, the throttle opening detection sensor, and the steering state detection sensor; wherein the control unit starts engine revolution reduction control when a state in which the throttle opening is smaller than the prescribed value is detected based on the signals from the aforementioned throttle opening detection sensor and a state of being steered is detected based on the signals from the aforementioned steering state detection sensor, and changes the speed of engine revolution reduction control when the filtered engine revolution under the state in which the engine revolution is under control is reduced to the value smaller than a prescribed engine revolution, and the aforementioned filtered engine revolution is a value obtained by multiplying a coefficient of resistance of the vessel to the change of engine revolution during a prescribed period of time.

[0012]

The invention according to Claim 2 is, in addition to

the construction as stated in Claim 1, characterized in that the aforementioned control unit starts engine revolution reduction control when a state of being steered with the filtered engine revolution and the throttle opening larger than the prescribed values is detected based on the signals from the aforementioned engine revolution detection sensor and from the aforementioned throttle opening detection sensor, and subsequently, a state in which the throttle opening is smaller than the prescribed value and a state of being steered are both detected.

[0013]

The invention according to Claim 3 is, in addition to the construction as stated in Claim 1 or 2, characterized in that the aforementioned control unit is adapted to perform such engine revolution control that engine revolution reduction control is started when a state in which the throttle opening is smaller than the prescribed value is detected, and subsequently, and the speed of engine revolution reduction is changed to the value different from the aforementioned reduction speed when a state of being steered is detected based on the signals from the aforementioned steering state detection sensor.

[0014]

The invention according to Claim 4 is, in addition to the construction as set forth in any one of Claims 1 to 3,

characterized in that the aforementioned speed of reduction control is determined based on the average engine revolution obtained by detecting the engine revolution for several seconds immediately before the throttle opening which is smaller than the prescribed value is detected for several times and averaging up the detected engine revolutions.

[0015]

The invention according to Claim 5 is, in addition to the construction as set forth in any one of Clams 1 to 4, characterized in that the engine revolution control by the use of the aforementioned speed of reduction control is performed by delaying the speed of closing of the throttle valve.

[0016]

The invention according to Claim 6 is, in addition to the construction as set forth in Claim 5, characterized in that when closing the throttle valve, the speed of closing of the throttle valve is delayed by controlling the speed of the backward movement of a push pin in a state in which the push pin of the stepping motor that moves forward and backward is abutted against the pressed portion of the aforementioned throttle valve.

[0017]

The invention according to Claim 7 is, in addition to the construction as set forth in Claim 3, characterized in that the engine revolution control is released and returned to the

initial state when the value obtained by dividing the filtered engine revolution by the initial revolution becomes smaller than the prescribed ratio of cancellation due to reduction of the engine revolution at the aforementioned reduction speed.

[0018]

The invention according to Claim 8 is, in addition to the construction as set forth in Claim 6, characterized in that the aforementioned push pin is adapted to be projected to the position in the vicinity of the pressed portion of the aforementioned throttle valve when the filtered engine revolution is larger than the prescribed engine revolution, and this state of being larger is continued for a prescribed period of time.

[0019]

The invention according to Claim 9 is, in a water jet propulsion boat that injects pressurized and accelerated water from an injection nozzle located at the rear by a jet propeller when the engine is driven, and moves forward with its rebound,

an engine output control device for water jet propulsion boats including: an engine revolution detection sensor for detecting the number of revolutions of the aforementioned engine; a throttle opening detection sensor for detecting the opening of the throttle of the aforementioned engine; a steering state detection sensor for detecting whether or not the steering handle is being steered; and a control unit for

controlling the engine revolution based on the signals from the aforementioned engine revolution detection sensor, the throttle opening detection sensor, and the steering state detection sensor; wherein the control unit performs such engine revolution control that the engine revolution is increased once and then is decreased when a state in which the throttle opening is smaller than the prescribed value is detected based on the signals from the aforementioned throttle opening detection sensor and a state of being steered is detected based on the signals from the aforementioned steering state detection sensor, and changes the speed of engine revolution reduction control when the filtered engine revolution under the state in which the engine revolution under control is lowered is a value smaller than the prescribed engine revolution, and the aforementioned filtered engine revolution is a value obtained by multiplying a coefficient of resistance of the vessel to the change of engine revolution during a prescribed period of time.

[0020]

The invention according to Claim 10 is, in addition to the construction as set forth in Claim 9, characterized in that the aforementioned control unit performs such engine revolution control that the engine revolution is increased once and then is decreased when a propelled state in which the filtered engine revolution and the throttle opening are larger

than the prescribed values is detected based on the signals from the aforementioned engine revolution detection sensor and the aforementioned throttle opening detection sensor, and subsequently, a state in which the throttle opening is smaller than the prescribed value is detected based on the signals from the aforementioned throttle opening detection sensor, and simultaneously, a steered state is detected based on the signals from the aforementioned steered state detection sensor.

[0021]

The invention according to Claim 11 is, in addition to the construction as set forth in Claim 9 or 10, the engine revolution is increased by connecting an auxiliary air passage to the air intake passage on the downstream side of the aforementioned throttle valve, and after a state in which the throttle opening is smaller than the prescribed value is detected, introducing air to the downstream side of the aforementioned throttle valve via the auxiliary air passage.

[0022]

The invention according to Claim 12 is, in addition to the construction as set forth in Claim 11, characterized in that the aforementioned air intake passages are provided for each plurality of cylinders, and the aforementioned auxiliary air passages are connected to each air intake passage, and in that the plurality of auxiliary air passage are converged, and

air flow rate adjusting means for adjusting the air flow rate is provided at the converged point.

[0023]

The invention according to Claim 13 is, in addition to the construction as set forth in any one of Claims 1 to 12, characterized in that the aforementioned predetermined engine revolution is determined based on the filtered engine revolution obtained after a state in which the throttle opening is smaller than the prescribed value is detected.

[0024]

The invention according to Claim 14 is, in addition to the construction as set forth in any one of Claims 1 to 13, characterized in that the aforementioned state in which the engine revolution is under control is released when the steering handle is returned to the neutral state in which said engine revolution control is being made.

[0025]

The invention according to Claim 15 is, in addition to the construction as set forth in any one of Claims 1 to 14, characterized in that the aforementioned state in which the engine revolution is under control is released when the operator opens the throttle in a state in which the aforementioned engine revolution control is being performed.

[0026]

The invention according to Claim 16 is, in addition to

the construction as set forth in any one of Claims 1 to 15, characterized in that restoration of the initial state is achieved when the engine revolution is reduced to the value smaller than the prescribed value after a state in which the aforementioned throttle opening is smaller than the prescribed value is detected and before a state of being steered is detected.

[0027]

[Preferred Embodiment of the Invention]

The embodiment of the present invention will now be described.

(First Embodiment)

Fig. 1 to Fig. 11 show The first embodiment of the present invention.

[0029]

The construction is described in a first place. As shown in Fig. 1, a vessel body 10 of the water jet propulsion boat is constructed of a hull member 11 and a deck member 12.

[0030]

A steering handle 13 is provided on the upper portion of the deck member 12 and a seat base 14 is provided so as to be lifted upward from the deck member 12 and extended rearward on the upper portion of the deck member 12 rearwardly of the steering handle 13. A saddle-type seat 15 is placed on the seat base 14.

[0031]

Formed on both sides of the seat base 14 on the deck member 12 between bulwarks projecting upward from both sides of the deck member 12 are steps for placing the legs of an operator straddling on the saddle-type seat 15.

[0032]

A two-cycle engine 16 is mounted in the engine room of the vessel body 10 and a jet propeller 17 is mounted in the pump chamber formed at the rear bottom portion of the hull member 11 of the vessel body 10. When an impeller 16a is rotated by an engine 16, water is sucked through the water sucking port 11a at the vessel bottom, and the water is injected rearward from the injection nozzle 18 of the jet propeller 17, thereby propelling the vessel body 10 toward the front.

[0033]

By laterally swinging a deflector, not shown, located rearwardly of the injection nozzle 18 by operating the steering handle 13, the vessel body 10 may be turned in the left and right directions.

[0034]

By operating a throttle lever 19 of the steering handle 13 shown in Fig. 2 and adjusting the opening of the throttle valve 22 of the engine 16 shown in Fig. 3, the engine output is adjusted and the velocity of the boat may be changed.

[0035]

The aforementioned engine 16 is, as shown in Fig. 4, an engine revolution detection sensor 25 is provided for detecting the engine revolution and a throttle opening detection sensor 23 is provided for detecting the opening of the throttle valve 22. And a steering switch 24 as a "steered state detection sensor" for detecting whether or not the steering handle 13 is steered is provided on the steering handle 13.

[0036]

The steering switch 24 outputs "1" as a steered state when the steering handle 13 is turned from the neutral position toward the left or the right by a prescribed angle, and outputs "0" as a not steered state in other cases.

[0037]

The aforementioned throttle valve 22 is rotatably supported by a throttle shaft 27 so as to open and close the air intake passage 26 of the aforementioned engine 16 as shown in Fig. 3, and the aforementioned throttle opening detection sensor 23 is provided at one end of the throttle shaft 27. A pulley 28 is provided on the other end of the throttle shaft 27 as shown in Fig. 4, and the pulley 28 and the throttle lever 19 of the aforementioned steering handle 13 are connected by a throttle cable 29, so that the vessel speed may be changed by operating the throttle lever 19 and adjusting the opening of the throttle valve 22.

[0038]

When the throttle lever 19 is gripped, the throttle valve 22 is opened against an urging force of the spring, not shown, via the throttle cable 29, and when the throttle lever 19 is released from the gripped state, the throttle valve 22 is rotated toward the closed position at a high speed due to the urging force of the spring. This state is "the case in which the throttle valve 22 returns in a normal speed", and the speed of engine revolution reduction in this case is the first reduction speed.

[0039]

A closed state detection switch 30 for detecting the closed state of the throttle valve 22 by detecting the rotated position of the pulley 28 is provided.

[0040]

Furthermore, as shown in Fig. 4, a stepping motor 33 for controlling the speed of closing the throttle valve 22 is disposed in the vicinity of the pulley 28, and the stepping motor 33 is provided with a push pin 33a is provided so as to move forward and backward at a prescribed timing and speed. The push pin 33a is, as schematically shown in Fig. 5, brought into and out of contact with the lever portion 27a, which corresponds to a "pressed portion" extended from the throttle shaft 27, to control the opening of the throttle valve 22.

[0041]

As shown in Fig. 4, the stepping motor 33, the throttle

opening detection sensor 23, the steering switch 24, the engine revolution detection sensor 25, closed state detection switch 30 are connected to the control unit 34 (hereinafter referred to as "ECU 34"). A stop switch 35 provided on the steering handle 13 is connected to the ECU 34 so that the engine 16 is stopped by turning the switch 35 ON.

[0042]

Referring now to an operation explanatory drawing in Fig. 5 and flow charts in Fig. 6 and Fig. 7, the engine revolution control by the ECU 34 will be described.

[0043]

In a state in which the engine is stopped shown in Fig. 5(a), or in a state in which the throttle valve 22 is closed, the push pin 33a of the stepping motor 33 is set to the rearmost position by the ECU 34.

[0044]

When the operator starts the engine 16 to bring it into the operating state, and when the requirements in the steps S1, S2, and S3 are satisfied as shown in Fig. 6, the stepping motor 33 is actuated, and the push pin 33a is projected by a prescribed extent and moved to a position close to but not in contact with the lever portion 27a of the throttle shaft 27 in the step S4 as shown in Fig 5(a) to Fig 5(b).

[0045]

In other words, in the step S1, whether or not so called

filtered engine revolution N1 is larger than the prescribed value (Ne1) during acceleration is determined. If YES, the step proceeds to the step S2, and if NO, it returns to the start.

[0046]

The prescribed value (Ne1) stated here is a value that allows generation of engine revolution at which an enough steering force for changing the direction of travel of the vessel body 10 can be generated, and is stored in a memory in advance. If such steering force is not generated in advance, the vessel cannot be steered even when the speed of engine revolution reduction is lowered. Therefore, it is required that a prescribed steering force is generated before control.

[0047]

The filtered engine revolution is an engine revolution subjected to the filtering process. The filtering process is to multiply the change of engine revolution (N2-N1=.N) between the time T1 and the time T2 by a resistance coefficient K of the vessel as shown in Fig. 8. For example, the period between the time T1 and the time T2 is suitably set to the range between 1 ms and 1000 ms, and the resistance coefficient K of the vessel, which is changed in accordance with the configuration or the like of the vessel, is suitably set to the range between 0.001 and 1.0.

[0048]

The filtered engine revolution after being subjected to

the filtering process is, as shown in the graph in Fig. 9, rises (changes) leniently as shown by the characteristic curve B indicated by broken line in the figure in comparison with the characteristic curve A of the actual engine revolution indicated by a solid line in the figure.

[0049]

With such filtering process, the characteristic curve B of the filtered engine revolution can be align substantially with the inclination of the actual vessel speed. Therefore, it is not necessary to dispose an apparatus for measuring the vessel speed separately and a value that is close to the substantial vessel speed can be detected without detecting the actual vessel speed by the use of the engine revolution detection sensor 25, which is already provided.

[0050]

In other words, for example, when the acceleration of the engine revolution is large within a prescribed period of time, the degree of the actual increase in vessel speed is smaller than the actual acceleration of the engine revolution due to the inertia of the vessel body 10. It is vise versa in the case of deceleration. Therefore, by performing the filtering process, the actual vessel speed can be grasped from the filtered engine revolution.

[0051]

Subsequently, in the step S2, whether or not the angle

of the throttle valve is larger than the prescribed angle (.1) is determined. If YES, the step proceeds to the step S3, and if NO, it returns to the start.

[0052]

The value of the prescribed angle ".1" is a value that allows generation of engine revolution at which an enough steering force for changing the direction of travel of the vessel body 10 can be generated, and is stored in a memory in advance.

[0053]

In the step S3, whether or not the prescribed period of time (T seconds) has passed is determined. If YES, the step proceeds to the step S4, and if NO, it returns to the start. Since a steering force is not necessary to be generated for a temporary increase in revolution because the vessel speed is low, and thus the step returns to the start.

[0054]

When the requirements in the step S1, S2, and S3 are satisfied, the stepping motor 33 is actuated in the step S4, and the push pin 33a is projected by a prescribed extent and moved to a position close to but not in contact with the throttle valve 22, and waits at this position (See Fig. 5(b)).

[0055]

In the step S5, whether or not the push pin 33a of the stepping motor 33 is projected by a prescribed amount (STP1)

is determined. If YES, the step proceeds to the step S6, and if NO, it goes back to the step S4.

[0056]

In the step S6, whether or not the angle of the throttle valve 22 is smaller than the prescribed angle (.2) or whether or not the opening of the throttle is smaller than the prescribed value, is determined. If YES, the step proceeds to the step S7 shown in Fig. 7, and if NO, it goes back to the step S5. When smaller, it is recognized that the throttle is turned OFF. The prescribed angle (.2) is an angle before the throttle valve 22 is completely closed.

[0057]

In the step S7, as shown in Fig. 7, the stepping motor 33 is actuated, and the push pin 33a removes backward at a prescribed speed (.STPA), and then the procedure goes to the step S8. When the throttle is turned OFF, the throttle valve 22 closes at a high-speed due to the urging force of the spring, while the push pin 33a moves backward at a speed slower than the latter (.STPA). Therefore, when in the course of the closing movement of the throttle valve 22, the lever portion 27a abuts against the push pin 33a as shown in Fig. 5(c). Subsequently, the throttle valve 22 closes in accordance with the returning speed of the push pin 33a.

[0058]

By the returning movement of the throttle valve 22 at

the speed of (.STPA), the engine revolution is reduced at the second reduction speed, which is slower than the aforementioned first reduction speed.

[0059]

The prescribed speed (.STPA) is determined based on the average revolution, which is calculated for a several seconds immediately before moving into the step S7, and is stored in the memory of the ECU 34 in advance. It is determined from the three-dimensional map A of the revolution of the engine 16, the returning angular speed of the throttle valve 22, and the returning speed of the push pin 33a.

[0060]

Since the steering force varies along with the vessel speed, a returning speed at which the satisfactory steering force is achieved according to the vessel speed may be obtained by detecting the engine average revolution immediately before, and then based on this value, determining the returning speed of the push pin 33a, and hence the returning angular speed of the throttle valve 22.

[0061]

In the step S8, whether or not the filtered engine revolution N2 is smaller than the prescribed value (Ne2) during deceleration is determined. If YES, the step proceeds to the step S9, and if NO, it proceeds to the step S10.

[0062]

The step S8 may be such that whether or not the value obtained by dividing the filtered engine revolution by the initial revolution is smaller than a prescribed rate of cancellation which is determined in advance is determined, and if YES, the step proceeds to the step S9 to terminate the engine revolution control, and if NO, it proceeds to the step S10.

[0063]

In the step S9, the push pin 33a of the stepping motor 33 moves to the rearmost position and terminates the engine revolution control state by the control unit 34.

[0064]

When the filtered revolution N2 is smaller than the prescribed value (Ne2) during deceleration, the vessel speed is slow and thus the steering force that can change the direction of travel of the vessel body 10 cannot be generated. Therefore, the engine revolution control is terminated.

[0065]

Referring now to Fig. 10, between the aforementioned step S5 and the step S6 shown in Fig. 6, when the throttle is turned OFF at the timing of a in Fig. 10, the throttle valve 22 closes fast by a urging force of the spring, and the engine revolution is abruptly reduced at the first reduction speed. The push pin 33a is maintained in the projected state.

[0066]

At the timing of b, when the throttle angle reaches .2,

the step moves from the step S6 in Fig. 6 to the step S7 in Fig. 7, and the push pin 33a moves backward at a prescribed speed (.STPA), and accordingly, the closing speed of the throttle valve 22 is lowered and thus the engine revolution is reduced at the second reduction speed, which is slower than the first reduction speed.

[0067]

Subsequently, at the timing of c, the filtered engine revolution N2 reaches the prescribed value (Ne2) with the steering switch 24 is not changed from "0" to "1" (not steered). When it becomes smaller than that value, the step proceeds from the step S8 to the step S9 shown in Fig. 7, and the push pin 33a moves backward at a speed faster than a prescribed speed (.STPA). Accordingly, the throttle angle is reduced, and the engine revolution is abruptly reduced.

[0068]

On the other hand, in the step S10, whether or not the steering switch 24 is changed from "0" to "1", or whether or not the vessel is steered, is determined. If YES (when steered), the step proceeds the step S11, and if NO (when not steered), it proceeds to the step S12.

[0069]

In the step S11, the speed of the rearward movement of the push pin 33a changes from the prescribed speed (.STPA) to the prescribed speed (.STPB), which is different therefrom,

and the step proceeds to the step S13.

[0070]

The prescribed speed (.STPB) is a speed of engine revolution reduction control, and is determined by the two-dimensional map B of the revolution of the engine 16 and the returning speed of the pres pin 33a, which are stored in the memory of the control unit 34 in advance, based on the engine revolution obtained by calculating an average revolution during several seconds immediately before moving into the step S7. The two-dimensional map B and the aforementioned three-dimensional map A are different maps.

[0071]

The reason why the different values of the prescribed speed (.STPB) and the prescribed speed (.STPA) are provided is that the vessel speed is smoothly reduced by quickly reducing the speed so as to prevent the operator from having a sense of discomfort when the vessel is not steered, while the steering force is ensured for a certain time period until the vessel body 10 is directed to the prescribed direction when being steered. Accordingly, the vessel can be steered with a natural feeling irrespective of whether the steering handle 13 is steered or not steered with the throttle turned OFF.

2
Speed
A

[0072]

In the step S12, whether or not the throttle angle is larger than the prescribed value (.3), or whether or not the

throttle valve 22 was opened on the operator's will again is determined. If YES (opened), the step proceeds to the step S9 to terminate the engine revolution control, and if NO (could not opened), it proceeds to the step S14.

[0073]

In the step S14, whether or not the value obtained by dividing the filtered engine revolution by the initial revolution is smaller than a prescribed rate of cancellation A which is determined in advance is determined, and if YES, the step proceeds to the step S9 to terminate the engine revolution control, and if NO, it goes back to the step S7. The initial revolution is a filtered engine revolution during the transition to the step S7.

[0074]

If it is larger, it is determined that the engine revolution that can generate an enough steering force for changing the direction of operation of the vessel 10 is still maintained, the step goes back to the step S7.

[0075]

On the other hand, in the aforementioned step S13, whether or not the steering switch 24 is changed from "1" to "0", or whether or not it is returned from the steered state to the neutral position, is determined. If YES, it is determined that the operator does not have a will to steer, and thus a steering force is not necessary. Therefore, the

step proceeds to the step S9, and then terminates the engine revolution control, and if NO, since the will to steer is not clear, it proceeds to the step S15.

[0076]

In the step S15, whether or not the filtered engine revolution N3 is smaller than the prescribed value (Ne3) during deceleration is determined. If YES, it is determined that the vessel speed is lowered enough and the vessel is steered to the desired state. Therefore, since the steering force is not necessary, after proceeded to the step S9, the speed of engine revolution reduction control is changed, and the engine revolution control terminates. In this case, since the filtered engine revolution N3 is used to grasp the state closer to the vessel speed and terminate the engine revolution control, the stopping distance cannot be elongated improperly, and thus the operator can steer and stop the vessel with a natural feeling. When it is larger, since the steering might be insufficient, the ECU 34 proceeds to the step S16.

[0077]

In the step S16, whether or not the throttle angle is not less than a prescribed angle (.4) is determined. If it yes, it is determined that the operator has a will to advance because the operator grips the throttle lever 19 and opens the throttle valve 22, and the lever portion 27a of the throttle valve 22 is away from the push pin 33a. Therefore, the step

proceeds to the step S9, and terminates the engine revolution control. When the throttle angle is smaller than the prescribed angle (.4), the step proceeds to the step S17.

[0078]

In the step S17, whether or not the value obtained by dividing the filtered engine revolution by the initial revolution is smaller than a prescribed rate of cancellation B which is determined in advance is determined, and if YES, the step proceeds to the step S9 to terminate the engine revolution control, and if NO, it goes back to the step S11, and continues the engine revolution control, and then repeats the step S13 and the like.

[0079]

Referring now to Fig. 11, from the timing b on, when the push pin 33a is moving backward at a prescribed speed (.STPA), and when the vessel is steered with the steering switch 24 changed from "0" to "1" at the timing d before the filtered engine revolution N2 reaches the prescribed value (Ne2), the step proceeds to the step S11 from the step S10, and the push pin 33a is moved backward at a reduction speed (.STPB), and accordingly, the throttle angle is reduced and the engine revolution is reduced at the second reduction speed. When the steering switch 24 is changed from "1" to "0" (neutral position) at the midpoint e, the step proceeds from the step S13 to the step S9. As shown by a broken line in Fig. 11, the push pin

33a moves backward at a speed faster than the prescribed speed (.STPB), and accordingly, the throttle angle is reduced and the filtered engine revolution also reduces. On the other hand, when it is not changed to the neutral position at the timing e, and when the filtered engine revolution N3 is smaller than the prescribed value (Ne3), the step proceeds to the step S9 from the step S15, and the push pin 33a moves backward at a speed faster than the prescribed speed (.STPB). Accordingly, the throttle angle reduces and the filtered engine revolution reduces.

[0080]

In this arrangement, when the throttle is turned OFF and the vessel is steered from the propelling state, the steering force can be maintained and satisfactorily steered by setting the returning speed of the throttle valve 22 to the value slower than the returning speed by the spring.

[0081]

The engine revolution control here needs to be performed from the state of having a steering force in advance, because it is not to increase the engine revolution that is once reduced, but to delay the speed of the engine revolution reduction. Therefore, the steering force can be ensured by controlling the engine revolution after the steering state is detected.

[0082]

In addition, the steering force can be maintained by

setting the returning speed of the throttle valve 22 to the value slower than the returning speed by the spring, even when the throttle is turned OFF from the propelling state and the vessel is not steered.

[0083]

Furthermore, when the engine revolution is controlled by delaying the returning speed of the throttle valve 22, and when the steering handle 13 is returned to the neutral position (the step S13), the filtered engine revolution became smaller than the prescribed value (the step S15), and the throttle is turned ON (the step S16), the object is achieved. Therefore, by releasing the engine revolution control, the operation thereafter can be made satisfactorily. Especially when the filtered engine revolution became smaller than the prescribed value, by releasing the engine revolution control, the stopping distance cannot be elongated improperly, and thus the vessel can be steered and stopped with a natural feeling.

[0084]

In this case, the actual engine revolution is detected, then the filtered engine revolution is calculated based thereon, and then the engine revolution is controlled by the use of the filtered engine revolution. Therefore, a device for detecting the vessel speed is not necessary and the vessel speed can be grasped by the use of the filtered engine revolution, whereby the engine revolution can be controlled satisfactorily.

[0085]

[Second Embodiment]

Fig. 12 to Fig. 18 are the second embodiment of the present invention.

[0086]

While the present invention is applied to the 2-cycle engine 16 in the aforementioned the first embodiment, the present invention is applied to the four-cycle engine 40 in this second embodiment.

[0087]

In other words, the engine 40 of the second embodiment is a four-cylinder four-cycle engine, and as shown in Fig. 13, throttle valves 22 are provided at four air intake passages 41 respectively so as to be capable of opening and closing, and the four auxiliary air passages 43 are connected to the respective air intake passages 41 on the downstream sides of the throttle valves 22 (on the side of the combustion chamber). These four auxiliary air passages 43 are converged to a point, and the converged portion 44 is slidably provided with an opening adjusting member 45 for adjusting airflow as shown in Fig. 14, so that the opening adjusting member 45 is slid by the stepping motor 46. The stepping motor 46 is controlled by the engine control unit 48 (hereinafter referred to as ECU 48) shown in Fig. 12.

[0088]

The ECU 48 is connected, as in the case of the first embodiment, to the engine revolution detection sensor 25 for detecting the engine revolution, and the throttle opening detection sensor 23 for detecting the opening of the throttle valve 22, and the steering handle 13 is connected to a steering switch 24 which corresponds to a "steered state detection sensor" for detecting whether or not the vessel is steered.

[0089]

Referring now to the flow chart and so on shown through Fig. 15 to Fig. 18, the engine revolution control by the ECU 48 will be described.

[0090]

When the operator starts the engine 40 to bring it into the operating state, and when the requirements in the steps S1, S2, and S3 are satisfied as in the first embodiment as shown in Fig. 15, the step proceeds to the step S4. Since the steps S1, S2, and S3 are the same as in the first embodiment, the description will not be made here again.

[0091]

In the step S4, whether or not the angle of the throttle valve 22 is smaller than the prescribed angle (.2) is determined. If YES, the step proceeds to the step S5, and if NO, it repeats the step S4. When it is smaller, it is recognized that the throttle valve 22 is in a closed state, that is, the throttle is turned OFF. In Fig. 17 and Fig. 18, the engine revolution

abruptly decreases from the timing a.

[0092]

In the step S5, whether or not the filtered revolution is smaller than the prescribed value (Ne2) during deceleration is determined. If YES, the step proceeds to the step S6, and if NO, to the step S7.

[0093]

When the steering switch 24 is not changed to "1", that is, the steering handle 13 is not turned OFF while the engine revolution is reduced from the timing a to the timing b in Fig. 18 and the filtered revolution reaches Ne2, the step proceeds to the step S6, and the opening adjusting member 45 is driven and closed by the stepping motor 46, whereby the engine revolution is maintained in a low revolution state and then is terminated.

[0094]

On the other hand, the step proceeds to the step S8 when the steering switch 24 is changed to "1", or the steering handle 13 is turned OFF at the timing c before the filtered engine revolution becomes the value smaller than the Ne2, and to the step S9 when it is not tuned.

[0095]

In the step S9, whether or not the throttle angle is larger than the prescribed angle (.2), or whether or not the throttle 22 valve was opened on the operator's will again is determined.

If YES (opened), the step proceeds to the step S6 to terminate the engine revolution control, and if NO (could not opened), it goes back to the step S5.

[0096]

In the step S8, the filtered engine revolution (N3) at that moment is stored, and in the step S10, the filtered engine revolution (Ne4) is calculated from the two-dimensional map based on the filtered engine revolution (N3) at the timing c. The filtered engine revolution (Ne4) is used as a condition of releasing the engine revolution control that will be described later.

[0097]

Subsequently, in the step S11, the opening adjusting member 45 is fully opened (the timing d in Fig. 18), and in the step S12, the opening adjusting member 45 is closed at a prescribed speed (.STPA). By opening the opening adjusting member 45, the engine revolution abruptly increases from the timing c to the timing d in Fig. 18, and the substantially same number of revolution has been maintained for a prescribed period of time, the engine revolution is reduced in accordance with the speed (.STPA) of closing the opening adjusting member 45.

[0098]

In the step S13, whether or not the steering switch 24 is changed from 1 to 0, of whether or not it is returned from

the steered state to the neutral position is determined. If YES, it is determined that the operator does not have a will to steer, and thus a steering force is not necessary. Therefore, the step proceeds to the step S6, and then terminates the engine revolution control, and if NO, since the will to steer is not clear, it proceeds to the step S14.

[0099]

In the step S14, whether or not the filtered engine revolution N4 during deceleration is smaller than the prescribed value (Ne4) in the aforementioned step S10 is determined. If YES, it is determined that the vessel speed is lowered enough and the vessel is steered to the desired state. Therefore, since the steering force is not necessary, after proceeded to the step S6, the engine revolution control is terminated, and if NO, the steering may not be enough, the step proceeds to the step S15.

[0100]

In the step S15, whether or not the throttle angle is not less than a prescribed angle (.2) or not is determined. If it yes, it is determined that the operator has a will to advance because the operator grips the throttle lever 19 and opens the throttle valve 42. Therefore, the step proceeds to the step S6, and terminates the engine revolution control.

[0101]

When the throttle angle is smaller than the prescribed

angle (.2), the step goes back to the step S12, continues the engine revolution control, and repeats the step S13 and so on.

[0102]

Referring now to Fig. 18, from the timing d on, when the opening adjusting member 45 is closed at a prescribed speed (.STPA), and when the steering switch 24 is chanted from "1" to "0" (neutral position) at the timing e before the filtered engine revolution reaches the prescribed value (Ne4), the step proceeds to the step S6 from the step S13, and the opening adjusting member 45 is moved backward at a reduction speed faster than the prescribed speed (.STPA), and accordingly, the engine revolution is abruptly reduced as represented by a broken line in Fig 18. On the other hand, when it is not changed to the neutral position, the filtered engine revolution is reduced to the value smaller than the prescribed value (Ne4), and thus the step proceeds to the step S6 from the step S14, where the opening adjusting member 45 moves backward at a speed faster than the prescribed speed (.STPA). Accordingly, the engine revolution abruptly reduces.

[0103]

Since the filtered engine revolution (Ne4) is used for releasing the engine revolution control state in the second embodiment, it can be released in accordance with the vessel speed, and thus a natural feeling of steering can be provided to the operator.

[0104]

When the value obtained by dividing the current engine revolution by the filtered engine revolution is not less than the prescribed value, it is determined that the vehicle body 10 ~~is~~ operated on the ground, and thus the overspeed in a state in which there is no cooling water can be prevented by limiting the throttle, ignition timing, or the amount of fuel injection.

[0105]

In the aforementioned embodiment, the engine revolution control is performed by delaying the return speed of the throttle valve 22 or forming the auxiliary air passage 43 for the air intake passage 41 and opening and closing the passage as needed. However, it is not limited thereto, and the engine revolution control can be performed by adjusting the ignition timing or the fuel injection timing or the like. Though returning speed of the throttle valve 22 is delayed by using the push pin 33a of the stepping motor 33, it is not limited thereto, and the returning speed of the throttle valve 22 can be adjusted by opening and closing the throttle valve by the motor and controlling the motor.

[0106]

[Effects of the Invention]

As is described thus far, according to the invention as set forth in the respective Claims, since it is constructed in such a manner that the reduction speed is changed when the

filtered engine revolution is reduced to the value smaller than the predetermined engine revolution, the operator can steer with more natural feeling even when the throttle is turned OFF.

[0107]

Since the engine revolution control is performed by the use of the filtered engine revolution, provision of a separate device for detecting the vessel speed is not necessary. Therefore, increase in the number of the components can be prevented, and thus a suitable control can be performed.

[0108]

According to the invention as set forth in Claim 2, the engine revolution control here needs to be performed from the state of having a steering force in advance, because it is not to increase the engine revolution that is once reduced, but to delay the speed of the engine revolution reduction. Therefore, the steering force can be ensured by controlling the engine revolution after the steering state is detected.

[0109]

According to the invention as set forth in Claim 3, the control unit is adapted to perform such engine revolution control that engine revolution reduction control is started when a state in which the throttle opening is smaller than the prescribed value is detected, and subsequently, and the speed of engine revolution reduction is changed to the value different from the aforementioned reduction speed when a state

of being steered is detected based on the signals from the aforementioned steering state detection sensor. Therefore, the engine revolution is reduced at a relatively fast reduction speed while ensuring the steering force before being steered, and is reduced at the speed of reduction control different from the aforementioned reduction speed after being steered, so that the operator can steer the vessel with more natural feeling.

[0110]

According to the invention as set forth in Claim 4, the speed of reduction control is determined based on the average engine revolution obtained by detecting the engine revolution for several seconds immediately before the throttle opening which is smaller than the prescribed value is detected for several times and averaging up the respective engine revolutions. Therefore, the speed of reduction control in accordance with the vessel speed can be set, so that the operator can steer the vessel with more natural feeling.

[0111]

According to the invention as set forth in Claim 5, the engine revolution control by means of the aforementioned speed of reduction control is performed by delaying the speed of closing of the throttle valve. Therefore, additional improvement of the construction is not necessary.

[0112]

According to the invention as set forth in Claim 14, the

state in which the engine revolution is under control is released when the steering handle is returned to the neutral state. Therefore, the operator does not have a will to steer in this state, and thus it is adapted to be stopped in the earlier stage, so that the operator can steer the vessel with more natural feeling.

[0113]

According to the invention as set forth in Claim 15, the state in which the engine revolution is under control is released when the operator opens the throttle in a state in which the aforementioned engine revolution control is being performed. Therefore, the operator has a will to advance again in this state, and thus it is adapted to allow a normal cruise by releasing a state in which the engine revolution is under control, so that the operator can steer the vessel with more natural feeling.

[0114]

According to the invention as set forth in Claim 16, since restoration of the initial state is achieved when the engine revolution is reduced to the value smaller than the prescribed value after a state in which the aforementioned throttle opening is smaller than the prescribed value is detected and before a state of being steered is detected, the operator can steer the vessel with more natural feeling.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a side view of a water jet propulsion boat according to the first embodiment of the present invention.

[Fig. 2]

Fig. 2 is a perspective view of a steering handle according to the first embodiment of the present invention.

[Fig. 3]

Fig. 3 is a schematic view of an engine showing the portion at which the throttle valve is disposed according to the first embodiment of the present invention in cross section.

[Fig. 4]

Fig. 4 is a block diagram showing an engine output control unit according to the first embodiment of the present invention.

[Fig. 5]

Fig. 5 is a schematic view showing the action of a stepping motor and a throttle valve according to the first embodiment, in which (a) shows a state in which the push pin is in the rearmost position, (b) shows a state in which the push pin is projecting, (c) shows a state in which a lever portion of the throttle valve abuts against the projected push pin, and (d) shows a state in which the lever portion abuts against the push pin, and thus the push pin is moved backward.

[Fig. 6]

Fig. 6 is a drawing showing the front half of the flow

chart according to the first embodiment.

[Fig. 7]

Fig. 7 is a drawing showing the rear half of the flow chart according to the first embodiment.

[Fig. 8]

Fig. 8 is a graph showing a relation between the time and the engine revolution according to the first embodiment.

[Fig. 9]

Fig. 9 is a graph showing a relation between the time and the engine revolution according to the first embodiment, showing a characteristic curve in the case where the filtering process is not applied, and a characteristic curve in the case where the filtering process is applied.

[Fig. 10]

Fig. 10 is a graph according to the first embodiment in which the lateral axis represents the time, and the vertical axis represents the filtered engine revolution and so on.

[Fig. 11]

Fig. 11 is a graph according to the first embodiment, in which the lateral axis represents the time, and the vertical axis represents the filtered engine revolution and so on.

[Fig. 12]

Fig. 12 is a block diagram showing an engine output control device according to the second embodiment.

[Fig. 13]

Fig. 13 is a schematic cross sectional view showing an air intake structure according to the second embodiment.

[Fig. 14]

Fig. 14 is a schematic cross sectional view of the converged portion of auxiliary air passages according to the second embodiment.

[Fig. 15]

Fig. 15 is a drawing showing the front half of the flow chart according to the second embodiment.

[Fig. 16]

Fig. 16 is a drawing showing the rear half of the flow chart according to the second embodiment.

[Fig. 17]

Fig. 17 is a graph according to the second embodiment, in which the lateral axis represents the time and the vertical axis represents the filtered engine revolution and so on.

[Fig. 18]

Fig. 18 is a graph according to the second embodiment, in which the lateral axis represents the time and the vertical axis represents the filtered engine revolution and so on.

[Reference Numerals]

10 vessel body

13 steering handle

16,40 engine

17 jet propeller

19	throttle lever
22	throttle valve
23	throttle opening detection sensor
24	steering switch (steered state detection sensor)
25	engine revolution detection sensor
26,41	air intake passage
27	throttle shaft
27a	lever portion (pressed portion)
29	throttle cable
33	stepping motor
33a	push pin
34, 48	control unit
43	auxiliary air passage
45	opening adjusting member
46	stepping motor

[Name of Document] ABSTRACT

[Abstract]

[Object] To provide an engine output control device for water jet propulsion boat that the operator can steer and stop with more natural feeling even when the throttle is turned OFF.

[Solving Means] The control unit 34 starts engine revolution reduction control when a state in which the throttle opening is smaller than the prescribed value is detected based on the signals from the throttle opening detection sensor 23 and a state of being steered is detected based on the signals from the steering switch 24, and changes the speed of engine revolution reduction control when the filtered engine revolution under the state in which the engine revolution is under control is reduced to the value smaller than a prescribed engine revolution, and said filtered engine revolution is a value obtained by multiplying a coefficient of resistance of the vessel to the change of engine revolution during a prescribed period of time.

[Selected Figure] Fig. 4